DETERMINATION OF CALLOVO-OXFORDIAN ARGILLITE DIFFUSION AND THERMAL CHARACTERISTICS BY INVERSE METHOD: TER AND DIR EXPERIMENTS

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In the framework of the research program on nuclear waste repository in deep geological formation, among others two in situ experiments were performed by ANDRA in Meuse/Haute Marne underground research laboratory to determine the callovo-oxfordian argillite characteristics: TER and DIR experiments. TER experiment was designed to determine THM behaviour of the host rock and thermal characteristics: thermal conductivity and specific heat capacity. DIR experiment was performed to characterize diffusion and retention of inert and reactive tracers in the host rock.

We determine the argillite thermal and diffusion characteristics by a numerical approach based on inverse method. First of all a direct method is applied by performing a physical modelling of the experiments. A single diffusion partial differential equation is used for the two experiments:

$$C_{(A)}\frac{A}{t} - \vec{\nabla}\cdot\left(\overline{\overline{D}}\vec{\nabla}A\right) = r$$

The diffusion equation is numerically solved by Finite Element Method implemented in CAST3M code; an unstructured mesh is used. The diffusion tensoris function of two coefficients; one characterizes diffusion parallelly to the bedding plane, the other perpendicularly. A first sensitivity analysis is made by direct modelling.

The same inverse method process is applied for the two sets TER and DIR experiment/modelling:

– a response surface (neural network) is made from CAST3M code: LHS experiment plan, composed by Kalif code, give a examples base used by Nemo neural network generator ;

– thermal or diffusion parameters identification is obtained by a minimization of objective function depending on experimental and calculated variables (Figure 1) ;

– sensitivity analyses are done in order to evaluate the confidence domain for parameters determination in function of data uncertainties.

In TER experiment, argillite characteristics to identify are longitudinal (λ_l) and transversal (λ_t) thermal conductivity, respectively along and perpendicular to the bedding plane, and specific heat capacity. The experimental variables are temperatures in the host rock at different locations and times. A 3D CAST3M model is used; the packer heat source is represented by a source term in the equation. All experimental data are available and TER is in dismantling phase. Back analysis of TER is difficult due to experimental uncertainties, mainly error on error location. Typical analysis of confident domain of parameters identification is given Figure 2.

In DIR experiment, argillite parameters to identify are longitudinal (D_l) and transversal (D_t) effective diffusion coefficients, and accessible porosity. The experimental and calculated variables are tracer normalized activities (or concentrations) in the diffusion chamber, and tracer specific activities (or concentrations) in argillite profiles overcored. Three zones are modelled: diffusion chamber, E.d.Z around the chamber and undisturbed argillite. Radioactive decay, dilution in the diffusion chamber and eventually sorption in the solid phase are taken into account. A 2D(r,z) axi-symmetric CAST3M model is used. Two

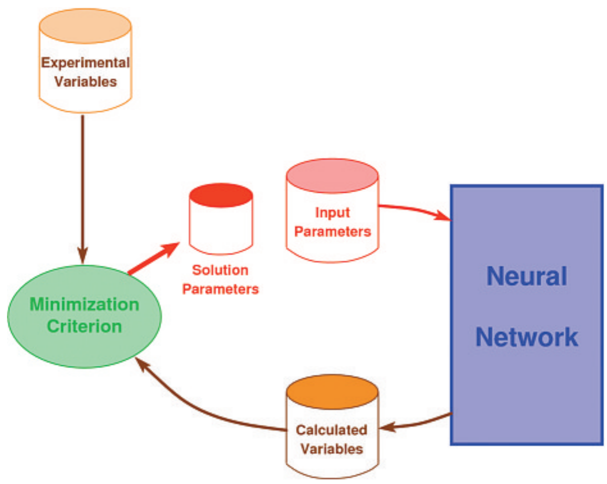

Figure 1: Optimization process.

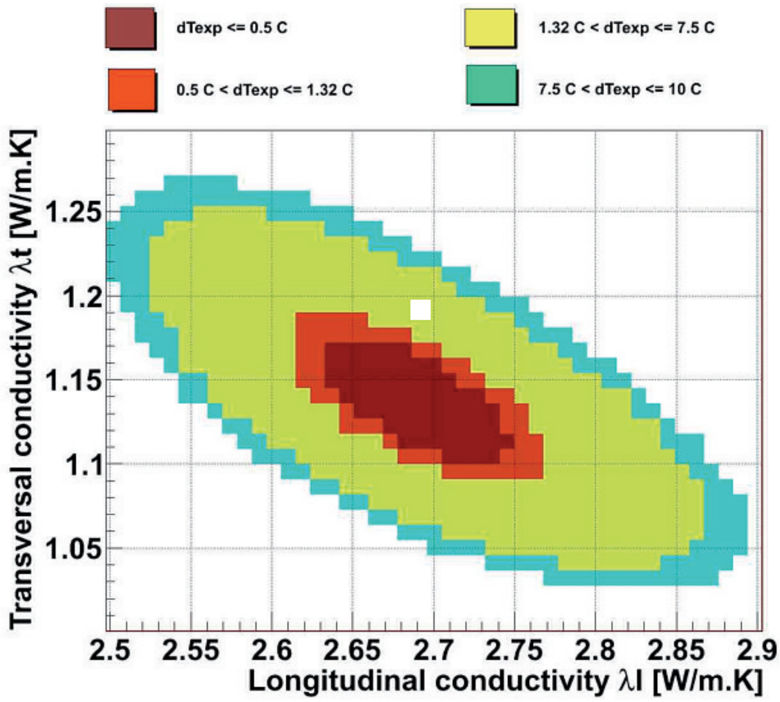

Figure 2: TER, minimal zones, at specific heat capacity 1189.5 J/(kg.K) for different experimental temperature uncertainties.

tracers are monitored in DIR2001 borehole, four tracers HTO, ^{36}Cl, ^{22}Na, ^{133}Cs in DIR2003 borehole. Direct and inverse methods are under progress.

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